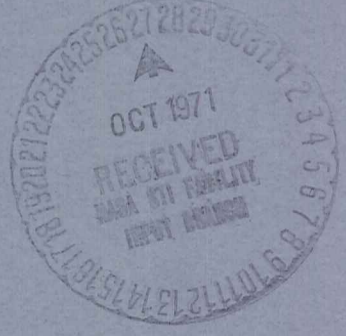
WHAT'S HAPPENING TO SMALL BUSINESS RESEARCH AND DEVELOPMENT?

Guy Black
May 1971



Staff Discussion Paper 303

PROGRAM OF POLICY STUDIES IN SCIENCE AND TECHNOLOGY

The George Washington University
Washington, D.C.

WHAT'S HAPPENING TO SMALL BUSINESS RESEARCH AND DEVELOPMENT?

Guy Black

May 1971

Staff Discussion Paper 303

Program of Policy Studies in Science and Technology
The George Washington University
Washington, D. C.
established under NASA Research Grant NGL 09-010-030

ABOUT THE AUTHOR

GUY BLACK is a Senior Staff Scientist in the Program of Policy Studies in Science and Technology at the George Washington University, Washington, D. C. and Associate Professor of Business Economics in their School of Government and Business Administration. From 1965 to 1967 he served as Executive Secretary of the President's Committee on the Economic Impact of Defense and Disarmament, and as a member of the staff of the Council of Economic Advisers. Prior to this he was a systems engineer and staff specialist in planning in the aerospace industry, and served on the staff of the Giannini Foundation at the University of California.

Dr. Black has been a consultant to the Electronic Industries Association, the Board of Economic Advisers to the Governor of Massachusetts, the National Planning Association, and was a member of the Panel on Science, Technology, and Regional Economic Development of the National Academy of Sciences/National Academy of Engineering. His publications include a book on *The Application of Systems Analysis to Government Operations* (Praeger, 1968).

Dr. Black studied at Harvard University and received a doctorate in economics from the University of Chicago in 1951.

WHAT'S HAPPENING TO SMALL BUSINESS RESEARCH AND DEVELOPMENT?

Guy Black*

The Small Role of Small Business in Research and Development

The attic inventor and the company that grew from a backyard garage to an industrial giant, are true stories of American enterprise. It would be a mistake, however, to believe that most inventions and most industries have such histories, or that much research and development is now performed in attics. Indeed, most companies perform no organized R&D at all. Compared with one and a half million active corporations, the National Science Foundation (N.S.F.) estimates that there are about 11,300 firms with R&D programs.[1] However, about 10,000 of these are companies with under 1000 employees, though few are small in the classic tradition of Horatio Alger. As a result, the portion of nationwide R&D performed by small companies is miniscule, even though industry performs about 70% of all R&D in the country--about $19 billion worth in 1970.[2] Industry's share is performed principally by the industrial giants--285 firms with over 10,000 employees performed about 84% of

---

*The comments of Thomas J. Hogan are gratefully acknowledged.

[1] U.S. Treasury Department, Internal Revenue Service, Statistics of Income 1965; U.S. Business Tax Returns (Washington, D. C.: Government Printing Office, 1968). See also, National Science Foundation, Research and Development in Industry 1968 (Washington, D. C.: Government Printing Office, 1970).

[2] V. J. Danilov, "Annual R&D Forecast: $28 Billion for Research," Industrial Research, January 1971, pp. 36-39.

the industry total. Roughly speaking, the 10,000 firms with less than 1,000 employees that had R&D programs in 1968 averaged only $72,000 per firm.[3]

Further, the average is that high because much of small-business R&D is performed by firms whose business is R&D contracting for government and large industrial firms. The results of this R&D rarely help the competitive position of small business. Small business R&D expenditures intended to give small firms new products and to discover new manufacturing methods are even smaller than the average suggests.

It might be expected that the slow-down in government R&D funding would reduce the advantage of the larger firms and we might, as a result, see a strengthening of small business R&D in the past few years. However, this does not seem to have happened. Since research and development are recognized as one of the mainstays of company growth and competitiveness, it is a matter of concern if small business underperforms on R&D. Maintaining its competitive position is an important national goal and we need to do what we can to maintain and strengthen the role of small business in R&D. Perhaps the whole national structure for R&D performance has been too much arranged for the advantage of the larger companies; it may have enabled them to grow at the expense of smaller businesses. Change in governmental policies might redress the balance. For example, governmental funding patterns seem especially favorable to the larger companies.

Within the past two years, the climate for R&D by industry has changed significantly. There has been a nearly unnoticed reversal of the

---

[3]National Science Foundation, op. cit., Table 12.

long-standing tendency for federal R&D funding to dominate the industrial R&D scene. Despite the tightening of the federal R&D pursestrings, industry has continued to increase its funding of R&D. The 1968 and the 1969 data (the latest available) show this, and forecasts for 1971 are that 59% of industry funds will be supplied by companies themselves-- an 18 year high.

The increases in federal R&D expenditures in the 1971 and 1972 budget proposals are less than cost increases. Space, atomic energy, and other traditionally major sources of funds show actual declines in real-dollar terms that new favorites such as urban transportation, environmental protection and crime control do not offset. The switch on the kinds of R&D government is funding has caused serious dislocations. Engineers and scientists trained to perform the defense-space R&D are not needed, unless they can reorient their skills to serve newly emphasized needs. The slowdown produced by anti-inflation policies has not reduced industry R&D spending, but in 1970-71 total new employment opportunities did not match the outflow of new engineers and scientists from our universities.

Comparing 1967 and 1968, federal funds for industrial R&D increased by less than 2 percent--and federal funds for small business actually shrank. Although small-firm programs did not match those of the larger firms in growth, the under-1000 firms increased their funding by 9 percent. These data show that despite federal R&D funding--a principal source of large-firm R&D funding becoming relatively less important--the smaller firms are still failing to match growth in the R&D funding of the larger firms and are continuing to fall behind them in R&D performance.

Thus, long-standing trends have not been reversed. For the period for which data are adequate, the evidence is fairly conclusive; there is

every reason for believing that it has been going on for decades. In 1958 the under-1000 companies performed 6% of total industrial R&D and in 1968 the percentage was down to 4%. Between 1958 and 1968 industrial performance of R&D increased 107%, but the funding of the under-1000 companies only increased 35%. Especially if account is taken of the rising cost of R&D performance, the position of small business has seriously deteriorated. Between January 1959 and January 1969 the full-time-equivalent number of R&D scientists and engineers in industry increased 44%, from 268 thousand to 386 thousand, while the number employed in firms of less than 1000 employees decreased from 40 thousand to 28 thousand.

In some respects the data on funding overstate the small business disadvantage. Some companies that were small in 1958 are now classified as large. Although the small business portion of funding was 4% in 1968, the under-1000 firms employed 7% of the full-time-equivalent R&D manpower; the difference is accounted for by the lower cost of R&D performance in the small companies.

Small firms seem to perform R&D more economically than the large. In 1968 their costs of $26,000 per R&D scientist or engineer compared with an all-industry average of $45,900. However, the comparison should be made cautiously. The median salary of engineers hired by industry in 1968 was $9,400 a year, and those who were 10 years beyond their bachelor's degree commanded a median of $13,850 (the respective medians were up to $10,500 and $15,000 in 1970). Since engineer and scientist wages run about 30% of R&D costs, applied to $26,000 these percentages yield only $7,800 to $9,100. Possibly smaller firms do not charge all overhead against R&D so that on a

full accounting basis their costs are higher than $26,000. Perhaps they over-reported the number of persons involved in R&D so that the denominator in the ratio of total R&D cost over total R&D personnel is too high, thereby indicating too low a per-capita cost. There is no way of telling from the data. In R&D, the average of $72,000 per firm for R&D of under-1000 firms does not go very far.

Two Kinds of Small Business R&D Performers

Who grows as a result of R&D depends on for whom the results of R&D are applied. When business firms perform contract R&D for the government, the most common result sought is new equipment purchased from industry by government. Obviously the firms that benefit are those with a manufacturing capability. To some extent this R&D may help non-governmental sales, though the amount of such spinoff is highly debatable. One barrier to more effective spinoff is that much government-funded R&D is performed by companies with no significant markets except the government.

A very large portion of small-business R&D is apparently performed by organizations that do not expect manufactured-good sales to result from their R&D efforts. These are the firms whose principal business is the performance of R&D--not the application of the results of R&D. Most of them are small enough to have under 1000 employees, so they are essentially small business. But the R&D which they perform is not particularly effective in improving the competitive position of small business. That which they perform directly for government may, in fact, result in production contracts awarded to large business. It is much the same story for subcontracts from larger firms which hold government contracts or when larger firms turn to R&D specialists to supplement the work of their own laboratories.

Just how important such firms are in the total small-business R&D picture is a statistical mystery. The data on "establishments primarily performing services of professional nature in the fields of engineering and architecture," include profit-making firms such as Arthur D. Little, but would exclude highly comparable non-profits such as Stanford Research Institute.[4] There are also some other types of non-manufacturing firms in the data, and the mixture of them with these specialist organizations affect the data for the under-1000 group and make it difficult to interpret that 38% of R&D performed by non-manufacturing firms (the classification which includes contract research firms) is performed by firms with less than 1000 employees, compared with the all-industry 4%.

That the specialists are an important element of this category is suggested by the statistic that 67% of the R&D funds in non-manufacturing industries is federal compared with the all-industry average of 49%. National Science Foundation data on the primary and secondary product fields of these non-manufacturing R&D performers shows that in order of importance the most important fields are electrical equipment and communication instruments, aircraft, guided missiles and space, machinery, and non-medicinal chemicals--except that the unclassifiable effort (things such as operations research, etc.) amounted to $165 million out of the $523 million of R&D by the non-manufacturing firms.

The other type of small business R&D performer is the type which

---

[4]Executive Office of the President, Bureau of the Budget, Standard Industrial Classification Manual, 1967 (Washington, D. C.: Government Printing Office, 1967).

most persons would think of first-- the firm which performs R&D in the hope of finding new products, improving existing products, or discovering new manufacturing methods. Unfortunately, there are few data on only the manufacturing firms in the under-1000 category in National Science Foundation statistics. Data on R&D as a percent of sales--for the small manufacturing companies that did any R&D at all--provide one way of comparing the level of R&D effort by company size. They show that the company-financed effort of the firms with fewer than 10,000 employees runs at about 1.5% of sales, and that the under-1000 manufacturing firms keep pace with the 1000 to 10,000 employee firms in company R&D funding. But company R&D funds are 2.3% of sales for the over-10,000 firms.

Out of $8,172 million of federal funds for manufacturing companies, only $85 million was for firms with less than 1000 employees. Only 3% of federal R&D funds for manufacturing industries was for firms with less than 5,000 employees, but 89% of federal funds for non-manufacturing firms was for such firms. These data suggest that the bulk of the R&D by the non-manufacturing under-1000 firms is by organizations that specialize in R&D and not by firms which seek new products and processes for their own use.

If this is so, it highlights the concentration of federal R&D, and company R&D as well, among the larger firms as it applies to the manufacturing industries. Expressed as a percent of sales, the contrast is very noticeable as shown in the following table of R&D as a percent of sales in 1967 and 1968 (manufacturing companies):

	1967	1968
Under 1,000 Employees		
Total	1.7%	2.0%
Federal	0.1	0.4
Company	1.6	1.6
10,000 or more		
Total	5.2	4.9
Federal	2.9	2.6
Company	2.3	2.3

Source: N.S.F. 70-29, pp. 58-59 (Note: data before 1967 are not directly comparable).

How Effective is Small Business R&D?

Why small business fails to maintain its position in the R&D picture is not entirely clear. It is more understandable why its R&D position is weak in the first place; for example, only very large organizations have the resources needed to reap the full advantages of its own R&D. Further, the inevitable diffusion of R&D results throughout industry--obviating the need for company-funded R&D--works less to the advantage of the large than the small firm, which can often exploit the R&D of the larger firms in specialized markets.

In a detailed case study of small firms the National Industrial Conference Board found "a positive association between a sustained and relatively large commitment to R&D and company growth has been established for small companies performing R&D."[5]

Fallout does not help the competitive position of small business relative to the large. If small business funds less R&D compared to big

[5]W.J.J. Smith and D. Creamer, R&D and Small Company Growth (New York: The Conference Board, 1968), p. 56.

business, it must be because comparatively it perceives the rewards as less, the costs as greater--more than big business, it has better alternative uses for funds than R&D, or it merely lacks funds for what it recognizes as sound expenditures. Undoubtedly, any of these factors sometimes apply for some firms, but to explain trends relative to big business there must be differential trends in the strength of these factors for big and small business.

It is by no means clear that small firms are less efficient in performing government R&D than the large ones, when the size of the task is commensurate with their resources. But in defense and space, so many projects--missiles, aircraft, ships, and tanks-- are inevitably very large projects for which only large firms have sufficient resources. Indeed, few of the larger projects are within the capability even of the large firms, which rely heavily on subcontracting and joint venture arrangements.

There is little reason for doubting that the contract research organizations perform R&D as efficiently as large manufacturing organizations. For many projects, their R&D teams match the large companies in size, and since R&D performance is their principal business, they probably manage it as well. Their principal difficulty may not be efficiency in R&D performance but in transferring R&D results to the factory. One of the reasons companies internalize R&D performance is to ease this transfer.

One of the principal considerations in judging the efficiency of R&D is the quality of the engineers and scientists employed. Apparently small business pays competitive salaries for the younger employees. Some part of differences in cost of R&D performance may be due to differences in salaries, though it cannot be much, according to data from the Engineers'Joint Council

on salaries for engineers in large or small industrial establishments.[6] For engineers within 5 years of graduation, the mean salaries are actually slightly higher in the smaller establishments. Beyond 5 years the larger establishments pay 3% to 4% higher salaries. A slightly greater portion of small establishment engineers are in the higher-paid older age group.

The efficiency of R&D also depends on the equipment and facilities engineers and scientists are given to work with, and the number of technicians and other support personnel at their disposal. Part of the cost difference may be in support personnel, facilities, and equipment; part of the difference may be an illusion. There also appear to be real differences in the type of R&D done by small and large businesses. The comparison is also affected by the different relative importance of small company R&D in various industries.

Although only 4% of the funds for R&D in all industries combined are spent in companies with under-1000 employees, in a few industries the small company is relatively more important. Chief among these is scientific and mechanical measuring instruments--an industry with few giants--where 33% of R&D funds are spent in below-1000 companies and there are only two R&D performers with over 10,000 employees. Small companies are also above-average in importance in the fabricated metal products industries, rubber products, drugs and medicines, chemicals, and machinery. They are far below average in aircraft and missiles, motor vehicles and other transportation equipment; somewhat below average in ferrous metals and food. These data parallel patterns of concentration within industries. These differences suggest that the effectiveness of the small firm in R&D performance compares favorably with the large firm if they choose the right industry to operate in.

---

[6] Engineers Joint Council, Professional Income of Engineers, 1970 (New York: Engineers Joint Council, 1970).

The Meaning of Trends

At face value, the data suggest that small-firm R&D have not fared as well in the past decade as large-firm R&D, especially with regard to its participation in federal contract R&D, but they do not permit a clear picture of the R&D participation of manufacturing industry as opposed to the contract R&D firm which is, after all, a special, if important, case. The following data, though suggestive, must be interpreted with an understanding that data in different years apply to a different group of firms:

	1958	1963	1968	68:58
	(dollars in millions)			
Federal R&D funds--all industry	$4,959	$ 7,270	$ 8,559	1.73
" --firms under 1000	233	194	225	97
Company R&D funds--all industry	3,630	5,360	8,876	2.45
" --firms under 1000	299	425	499	1,67
Total R&D funds--all industry	8,389	12,630	17,435	2.08
" --firms under 1000	532	619	723	1.36
Federal funds - % for under 1000	5%	3%	3%	
Company funds - % for under 1000	8%	8%	6%	
All funds - % for under 1000	6%	5%	4%	
All funds - % of federal for industry	59%	58%	49%	
All funds - % of federal for under 1000	44%	31%	31%	

To speculate on these matters, my suspicions are that the continuing rise in the cost of R&D performance has had more of an impact on small business management than large. Between 1966 and 1970 the median starting salaries for beginning B.S. engineers increased over 25%--from $8,350 to

$10,000. An instinctive reaction to higher costs is to pull back--until convinced to spend as a result of careful analysis. Small companies lack the specialized staffs for analyzing expensive R&D, and the higher the costs, the more they may be influenced. In a small-company atmosphere, high starting salaries for junior personnel create problems that a larger company can avoid by isolating R&D personnel in a separate laboratory.

In recent years the extent to which small companies are able to reap the rewards of their own R&D may easily have taken a turn for the worse. Marketing institutions increasingly favor the large national company. Small firms lack the resources needed to saturate the national market with a new product, which makes them vulnerable to the big company with a national sales organization, once they expose their idea.

If rewards from R&D are becoming less, rewards elsewhere may be getting better. I suspect that improving opportunities for small enterprises in commercial and service industries rather than manufacturing, is unfavorable to small business R&D. To some extent investment funds for small business come from those who wish to combine financing with involvement--and increasingly the kinds of investors who would like a stake in a small business are being attracted to service or commercial enterprises. It is here that R&D is least effective as a company strategy.

What To Do

Small business is, apparently, not maintaining its R&D position even as well as its sales position relative to the larger firms. In 1957 R&D performing manufacturing companies spent 1.5% per dollar of sales on R&D. In every year since 1964 the percent has been 2.0% or higher. The small

firms have not matched this increase. In 1957 they spent only slightly less than the industry average--1.4% of their sales on R&D. In the 1964-68 period they averaged only 1.5% of sales on R&D--about where all-industry average was a decade earlier.

Small business needs and can profit from R&D. It cannot be seriously argued, for example, that small business needs less R&D because of fallout of R&D ideas from government and big industry. This fallout is just as available to the larger firms, which often are much better organized to locate and use it.

Do we care what happens to small business R&D, and can anything be done about it? Little can be done about costs. Small business might be helped to make better management evaluations of the potential in R&D and in the design of efficient small R&D programs. With respect to investment, the small business investment idea seems to have considerable merit--but it did not work particularly to the advantage of the R&D-oriented firm.

Small business preferential treatment in governmental contracting, free governmental services for small business R&D, and subsidies undoubtedly can be developed and made to work. Whether they are worth the price depends on the value placed on small business R&D. A case can be made that, especially in R&D, we cannot afford to allow extreme concentration.

STANDARD TITLE PAGE FOR TECHNICAL REPORTS	1. Report No. GWPS-SDP 303	2. Govt. Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle WHAT'S HAPPENING TO SMALL BUSINESS RESEARCH AND DEVELOPMENT?			5. Report Date May 1971 6. Performing Organization Code
7. Author(s) Guy Black			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Program of Policy Studies in Science & Technology The George Washington University Washington, D. C.			10. Project Task Work Unit No. 11. Contract Grant No. NASA NGL 09-010-030
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration 400 Maryland Avenue, S.W. Washington, D. C.			13. Type of Report & Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstracts

Very few small manufacturing firms perform any R & D, and their programs are smaller relative to sales than large firms. Much of the reported R & D by small business is by contract research organizations, where results infrequently improve the competitive position of small manufacturing business. Although Federal R & D funding in industry has been concentrated in the larger firms, the recent decline has not improved the relative position of the small firms. Possible explanations are that trends in marketing and mass media advertising make it increasingly difficult for small firms to reap rewards from their R & D; also, small business investment opportunities are increasingly in the service and trade industries where R & D performance has always been low.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers Open-Ended Terms

17c. COSATI Field/Group

18. Distribution Statement	19. Security Class (This Report)	21. No. of Pages
Releasable to public without limitation. Initial distribution from Program of Policy Studies; all subsequent copies only from NTIS.	UNCLASSIFIED	15
	20. Security Class (This Page) UNCLASSIFIED	22. Price $3.00